HAIR SHAFT DISORDERS

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INTRODUCTION

- Hair shaft composed of multiple layers including:
  - Medulla
  - Cortex
  - Cuticle
- Medulla is loosely packed region near centre of hair, may be continuous, discontinuous or absent along hair shaft

- Medulla is surrounded by cortex which contain keratin proteins and structural lipid
- Medulla and cortex is surrounded by cuticle, protective layer of overlapping cells that envelope hair

Hair shaft disorders can be classified into:
- Hair shaft disorders associated with hair breakage
- Hair shaft disorders associated with unruly hair, but none or little hair breakage
- Others

CLASSIFICATION

- Hair shaft disorders associated with hair breakage
  - trichorrhexis nodosa
  - trichoschisis
  - pili torti
  - trichorrhexis invaginata
  - monilethrix

- Hair shaft disorders associated with unruly hair, but none or little hair breakage
  - uncombable hair syndrome
  - wooly hair
  - Marie Unna hereditary hypotrichosis
  - hypotrichosis
**TRICHORRHEXIS NODOSA**

**EPIDEMIOLOGY**
- Trichorrhexis nodosa (TN) is the most common hair shaft disorder associated with breakage.

**CLINICAL FEATURES**
- brittle, easily broken, and lusterless hair with white nodular swellings at irregular intervals along the hair shaft
- Patients complain of inability to grow hair past a certain length.

**ETIOLOGY/RISK FACTORS**
- can either be acquired or inherited
- Acquired TN is the more common subtype and is caused by external trauma, which includes
  - mechanical
  - chemical
  - thermal injury

**Acquired TN has been divided into 3 groups based on position**
- localized
- proximal
- distal

**Localized TN usually presents as isolated patches that occurs from mechanical trauma secondary to a pruritic dermatosis**
- Proximal TN due to use of strong chemical and heat straightening treatments
Distal TN associated with frequent shampoo use, brushing, and chemical treatments such as bleaching

Other causes of acquired disease include malnutrition, iron deficiency, and hypothyroidism.

Congenital TN
- TN is inherited, it occurs at birth or within a few months of birth
- Autosomal dominant condition

Congenital TN can be associated with metabolic disorders such as arginosuccinic aciduria and citrullinemia

Arginosuccinic aciduria and citrullinemia are a group of urea cycle disorders caused by a deficiency of enzymes required to convert toxic ammonia into urea

Clinical manifestations of these diseases are mostly due to hyperammonemia, which affects the central nervous system

Arginosuccinic aciduria
- Inborn error of urea synthesis
- Due to deficiency of arginosuccinic lyase
- Present with failure to thrive and mental retardation
- Hair finding of TN is an important diagnostic clue in this syndrome
- Patients have normal hair at birth but then develop TN when they are 1–2 years of age

Citrullinemia
- Rare genetic error of the urea cycle
- Deficiency of argininosuccinate synthetase
- Results in increased blood ammonia, citrullinemia, and decreased arginine level
- Patients with this syndrome have abnormally fragile hair with TN

Diagnosis of TN
- Light and electron microscopy
- Characteristic finding is a splayed paint brush bristle appearance
- Caused by a breach in the cuticle leading to exposure of the fibers increasing their susceptibility to fracture
Differential Diagnosis of Trichorrhexis Nodosa
- Alopecia areata
- Androgenic alopecia
- Monilethrix
- Seborrheic dermatitis
- Telogen effluvium
- trichotillomania

MANAGEMENT
- Acquired TN is often a self-limited and reversible disease
- Management involves avoiding harsh chemical treatments, excessive hair brushing, heat exposure, and mechanical trauma such as rubbing or scratching
- Resolution to normal hair will occur within 2 to 4 years
- Additional use of a protein-enriched shampoo, as well as cutting the hair in cases of distal damage, may prevent future reoccurrence of TN.

TRICHOSCHISIS AND TRICHOPTHIODYSTROPH
- Trichoschisis refers to a localized absence of cuticle that leads to exposure and a clean transverse fracture of the hair shaft
- Trichoschisis is associated with low-sulfur containing hair seen in trichothiodystrophy (TTD), but can also occur secondary to external trauma.

EPIDEMIOLOGY
- TTD is an extremely rare condition occurring in 1 in 1 million live births
- TTD is associated with defects in genes involved in DNA repair and transcription
- Trichoschisis can more frequently be caused by external trauma from heat, chemicals, relaxants, and excessive brushing
• CLINICAL FEATURES
  - brittle, easily broken hair
  - short, brittle eyebrows and eyelashes
  - When trichoschisis occurs as part of TTD, clinical features include cutaneous findings such as lamellar ichthyosis, brittle nails, short stature, mental retardation, facial dysmorphisms, and gonadal dysgenesis
  - Photosensitivity is seen in some forms of TTD

• Inherited Syndromes of Trichothiodystrophy
  - BIDS (Amish brittle hair syndrome) Brittle hair, brittle nails, intellectual deficiency, decreased fertility, short stature, ataxia, seizures, and microcephaly
  - IBIDS (Tay syndrome) Brittle hair, brittle nails, intellectual deficiency, decreased fertility, short stature, ichthyosis, ectodermal dysplasia

• PIBIDS Brittle hair, brittle nails, intellectual deficiency, decreased fertility, short stature, ichthyosis, photosensitivity

• ETIOLOGY/RISK FACTORS
  - localized absence of cuticle seen in trichoschisis can be a consequence of mechanical trauma from excessive styling, brushing, or combing
  - Chemical treatments, such as dye or bleach, may strip away the cuticle and cause local breakage

• When it occurs congenitally, trichoschisis is seen in TTD and is associated with sulfur-deficient and cysteine-deficient hair

• TTD is an autosomal recessive disorder that is linked to 4 major genes: ERCC2, ERCC3, p8, and C7Orf11

• DIAGNOSIS
  - “tiger tail” hair with light and dark alternating bands is seen on polarized light microscopy
  - alternating pattern is related to irregular sulfur content of the hair, with lighter areas representing lower sulfur concentrations
  - Diagnosis can be confirmed by genetic testing
• hair cysteine and sulfur content in TTD is less than 50% of normal in the cuticle and the cortex of the hair

• MANAGEMENT
  ◦ If trichoschisis is acquired, reducing hair manipulation can result in resolution of symptoms
  ◦ In cases of TTD, no effective treatment modality has been identified.

• PILI TORTI
  ◦ Pili torti ("twisted hair") is characterized by hair shafts that are flattened and twisted 180 degrees along their long axis
  ◦ CLINICAL FEATURES
    ◦ Hair is brittle, dry, and appears spangled as a result of uneven light reflections
      ◦ weak points of the twists result in shorter hair with increased fragility
    ◦ Coarse hair or areas of alopecia are especially prevalent in the parietal and occipital areas
  ◦ EPIDEMIOLOGY
    ◦ presents within the first 3 years of life
    ◦ less common, postpubertal form
Hair is fair in appearance, except in postpubertal cases where darker hair areas of alopecia observed 
- scalp is the primary area affected, but eyebrows, eyelashes, and other body hairs may be involved 
- Neurologic disorders, hearing loss, and ectodermal dysplasia may be found

Pili torti can be part of other syndromes:
- Bjornstad syndrome: Autosomal recessive condition. The patient will have both pili torti and sensorineural hearing loss 
- Crandall syndrome: Autosomal recessive condition. The patient will have pituitary hormones dysfunction, hypogonadism, pili torti, and deafness

Menkes syndrome:
- X-linked recessive condition. It is due to a mutation in the X-linked ATP7A gene, which encodes a copper-transporting ATPase 
- maldistribution of the body’s copper leading to dysfunctions of all processes that need this element

Patient have sparse, pale, lightly pigmented hair with a steel wool appearance 
- Eyebrows are affected, too 
- skin is pale and doughy with a bowed upper lip 
- associated vascular, neurological, and skeletal dysfunction due to decrease in activity of copper-dependent enzymes

Bazex–Dupré–Christol syndrome (BDC syndrome)
- rare X-linked dominant disorder. 
- characterized by triad of 
  1) follicular atrophoderma, especially on the dorsum of hands and feet 
  2) multiple basal cell carcinomas on the face, occurring mainly during the second decade of life 
  3) congenital generalized hypotrichosis with associated hair shaft abnormalities
• MANAGEMENT
  ◦ No effective treatment for pili torti has been identified. Chemical and/or mechanical trauma should be reduced to avoid further breakage

TRICHOHRHEXIS INVAGINATA
• Trichorrhexis invaginata (bamboo hair) is commonly associated with Netherton syndrome and characterized by invagination of the distal hair shaft into the proximal portion
• may also occur as an isolated condition or sporadically with other hair shaft abnormalities

Figure 89-5 Golf-tee appearance of hair shaft under light microscopy.

• CLINICAL FEATURES
  ◦ Hair has a dry, lusterless, brittle appearance with increased fragility
  ◦ Areas of diffuse thinning with some instances of complete alopecia are present

• ETIOLOGY/RISK FACTORS
  ◦ Netherton syndrome is an autosomal recessive disorder involving the gene serine protease inhibitor, Kazal type-5 (SPINK5)
  ◦ Hair shaft abnormalities seen in Netherton syndrome may be the result of intermittent incomplete formation of disulfide bonds in the keratogenous zone

• Eyebrows and eyelashes are also affected
  ◦ Netherton syndrome clinical triad includes atopic diathesis, ichthyosiform erythroderma, and trichorrhexis invaginata
**MANAGEMENT**
- Cutaneous features of Netherton syndrome are managed with the use of emollients, topical steroids, and topical immunomodulators such as tacrolimus and pimecrolimus
- Systemic therapies include low-dose corticosteroids, retinoids, and phototherapy

**MONILETHRIX**
- Monilethrix is a rare genetic disorder associated with increased fragility and a pathognomonic beaded hair appearance

**CLINICAL FEATURES**
- Clinically apparent within the first few months of life after lanugo hair is shed and replaced with short, dry, and lusterless hair
- Hair is sparse with increased fragility

**EPIDEMIOLOGY**
- Appears early in infancy
- Occurs in an autosomal dominant pattern
- Although reports of autosomal recessive inheritance have been documented

**ETIOLOGY**
- Beaded hairs emerge from keratotic follicular papules that are primarily seen in the occiput
- Severe forms can affect eyebrows, eyelashes, and generalized body hair
- Association with keratosis pilaris, nail defects (koilonychias), cataracts, teeth abnormalities, syndactyly, oligophrenia, and mental disability
- Three genes have been associated with monilethrix AD (KRT81, KRT83, and KRT86, coding for the type II hair keratins Hb1, Hb3, and Hb6)
- Autosomal recessive form, caused by a mutation in the DSG4 gene, encoding for desmoglein 4 protein
• **DIAGNOSIS**
  - Trichoscopy will show normal medullated nodes of hair, along with non-medullated internodal thin hair at regular intervals.
  - Internode represents the diseased abnormal hair where it can be easily fractured.
  - Light microscopy shows typical beaded or moniliform appearance of the hair.

• **MANAGEMENT**
  - Oral retinoids and topical minoxidil may be of some benefit.

• **UNCOMBABLE HAIR SYNDROME**
  - Autosomal dominant Acquired forms
  - Common in dark, curly haired individuals
  - Unruly, frizzy, dry hair
  - No increased fragility
  - Eyebrows, eyelashes, and body hair are not affected

• Electron microscopy: triangular/kidney-shaped crosssectional appearance with longitudinal grooving
  - Usually resolves after puberty
  - Biotin supplementation may be of help.
MARIE-UNNA HEREDITARY HYPOTRICHOSIS
- Autosomal dominant condition
- Sparse, absent hair; regrowth may be coarse, wiry and unruly in childhood, but hair loss may recur at puberty
- Total alopecia may be present
- Associated milia-like lesions and follicular hyperkeratosis

WOOLY HAIR
- Autosomal dominant (KRT71) and autosomal recessive (type I: P2RY5 or LPAR6, type II: LIPH), as well as sporadic forms
- Tight curls with an average diameter of 0.5 cm
- Brittle hair with no increased fragility
- Light microscopy and scalp biopsy are normal

HEREDITARY HYPOTRICHOSIS SIMPLEX
- 4 Autosomal dominant subtypes (HYPT1-4) and 6 autosomal recessive subtypes (HYPT 5-10)
  - Diffusely sparse, fine, short hairs
  - Follicular miniaturization and inflammatory alopecia
- Body hair may be involved
**Light and electron microscopy: focal areas of defect in cuticle**
- Scalp biopsy: decreased number of follicles
- Complete baldness by age 30 years

**LOOSE ANAGEN SYNDROME**
- Sporadic and inherited condition (autosomal dominant)
- Hair is diffusely sparse, and easily pulled from the scalp without pain
- No increased hair fragility, but hair may be difficult to comb
- Pull test: increased anagen hairs

**Light microscopy: anagen hairs with distorted bulbs, cuticles have a “floppy sock” appearance**
- Trichogram: 70% anagen hairs
- Resolves with age; when LAS presents late, hair loss more likely to be persistent
- Gentle hair care, 5% minoxidil

**PILI ANNULATI**
- Sporadic, or inherited (autosomal dominant)
- Characterized by alternating light and dark bands
- Hair has a “speckled” appearance
- Trichoscopy: alternating white and dark bands
- Light microscopy: reversal of white and dark bands
- Electron microscopy: shows a cobblestone appearance of the cuticle
- Clinical features become more prominent with age